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The Mosquito Plague of the Connecticut Coast Region and How to Control it.

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THE MOSQUITO PLAGUE OF THE CONNECTICUT COAST REGION AND HOW TO CONTROL IT.

By W. E. Britton, *State Entomologist.*

The reason for publishing a bulletin on this subject at this time is to supply information to those who are now engaged in the work of controlling mosquitoes in Connecticut and to encourage and direct the efforts of others who are interested and soon to take up such improvement work.

The salt marshes along the coast furnish the principal part of the mosquito plague of the southern portion of the State. Contrary to the habits of most mosquitoes, those of the salt marsh species fly inland long distances, and as they are large and very abundant, and are voracious feeders, they make life a burden to many inhabitants, and keep away many others who would otherwise summer on the Connecticut coast. This condition results in preventing the proper development of a legitimate business and the people of the State are so much the poorer on account of it. That the remedy is not impossible, nor impracticable, nor so expensive as most people suppose, and that for agricultural purposes the land is greatly improved by the treatment, the details given on the following pages will show:—

MOSQUITOES OF THE SALT MARSH.

There are two species of mosquitoes which breed abundantly on the salt marshes and which are commonly called salt marsh mosquitoes—the brown salt marsh mosquito *Culex cantator* Coq. and the banded salt marsh mosquito *Culex sollicitans* Walk.

THE BROWN SALT MARSH MOSQUITO.

The brown salt marsh mosquito *Culex cantator* Coq. is large and uniformly reddish brown in color without conspicuous markings, though there are narrow white bands on the legs and on the abdomen. It is shown in figure 1. Breeding upon the salt marsh early in the season, the females bite fiercely and migrate long distances in search of food, going chiefly inland which in Connecticut is the direction of the prevailing winds. About July

1st, it is almost or wholly replaced by the banded salt marsh mosquito, which is present during the remainder of the season.

THE BANDED SALT MARSH MOSQUITO.

On account of its white markings this is the most conspicuous mosquito of medium size found in Connecticut. All of the legs are banded, dark and white alternating, and the front margin of

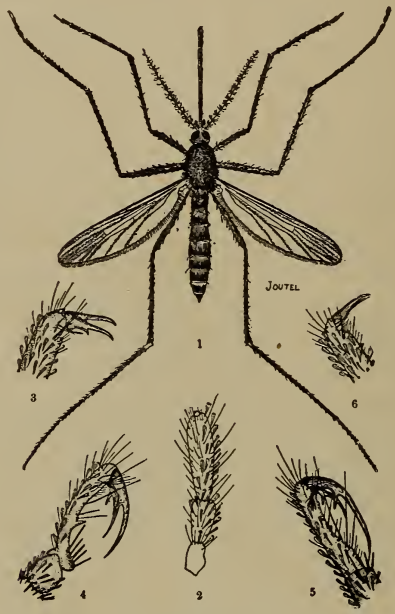

FIG. 1.—The brown salt marsh mosquito, *Culex cantator* Coq.: 1. adult female: 2. palpus; 3. anterior claw of same; 4. 5. 6. anterior, median and posterior claws of male. All enlarged. (After Smith, Report on New Jersey Mosquitoes.)

each abdominal segment is also white and there is a dorsal longitudinal white line on the abdomen. In addition to these striking characters there is a white band upon the beak, about half way between base and tip, and these markings together serve to distinguish this from all other species of mosquitoes.

The eggs are laid on the mud of the salt marsh pools and hatch when the pools fill with water. About a week is required in warm weather from the hatching of the egg to the emergence

of the adult mosquitoes, which come in swarms or broods and are often extremely abundant, and the females bite ravenously. They migrate inland in search of food, sometimes going twenty-five or thirty miles. It seems to be necessary for the females to obtain blood from one of the higher animals in order to develop their eggs. Most of them are probably able to obtain food within from five to ten miles of their breeding places.

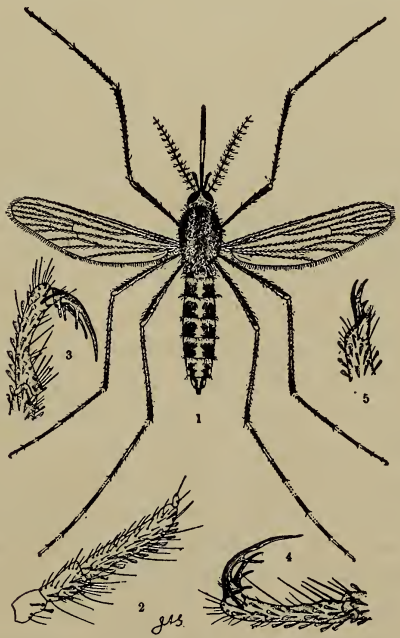

FIG. 2.—The banded salt marsh mosquito, *Culex sollicitans* Walk.: 1. adult female; 2. palpus: 3. anterior, 4. median and 5. posterior claws of male. All enlarged. (After Smith, Report on New Jersey Mosquitoes.)

The banded salt marsh mosquito is far more abundant than the brown salt marsh species, and appearing later in the summer, constitutes the mosquito plague of the shore region, remaining until cool weather prevents further mosquito breeding. This mosquito is the one commonly called the salt marsh mosquito and is shown in figure 2.

Of course there are several species of fresh water mosquitoes of the genus *Culex,* and malarial mosquitoes, *Anopheles,* breeding in the fresh water pools in the rear of nearly every salt water

marsh, and rain barrel mosquitoes breed in the cisterns and other receptacles around the shore cottages, but these are local and do not fly far. They do not as a rule breed in salt or brackish water, and do not constitute any important part of the mosquito plague of the Connecticut coast region.

AREA OF SALT MARSH IN CONNECTICUT.

The salt or tide water marshes of Connecticut contain 22,264 acres or 34.79 square miles,* distributed rather unevenly, along the coast in the southern part of the State. The marsh areas are the most extensive in the middle part of the coastal region, or that portion bounded on the west by the Saugatuck, and on the east by the Connecticut rivers. A considerable portion of the coast is hard land, being gravelly or rocky and there are few large tidal marshes, the largest in the whole state being the Quinnipiac marsh, near New Haven, of over 3,600 acres in extent.

CONDITION OF THE SALT MARSH AREAS.

In the report of the Mosquito Survey of Connecticut, made in 1904, and published in the report of this station for that year, page 285, it was stated that fully 50 per cent. of the entire salt marsh area of the State had at some time been thoroughly drained for salt hay farming. Other portions are well drained naturally, and so are not serious breeders of mosquitoes.

In recent years, however, salt hay farming seems to have been neglected, though it is hard to understand why; as the hay still brings a price ranging from $7.00 to $12.00 per ton, and there is quite a demand for it for packing, bedding and mulching material. Many salt marshes have been neglected, the old ditches have become clogged, filled or grown up and few new ones have been cut. Such marshes are prolific breeding places of salt marsh mosquitoes. From personal observations, and from conversation with some of the older residents, we may safely conclude that in many cases at least the marshes are in worse condition to-day than they were thirty or forty years ago and mosquitoes correspondingly more numerous. Wherever the

* D. M. Nesbit, Miscellaneous Special Report No. 7. The Marshes of the United States, U. S. Department of Agriculture, 1884.

marsh becomes sufficiently congested, water stands, the turf rots and a depression is formed which increases in size and breeds millions of mosquitoes.

Nearly every salt marsh receives more or less fresh water from springs or streams emerging from the highland. This water must pass through the marsh to reach the ocean. Some marshes are so congested that the fresh water cannot drain off but is kept back, making soft bogs with considerable stagnant water. Often the highest and dryest part of the salt marsh is near the outlet, while the lowest portion is at the back side next to the highland. In such places, and often nowhere else upon the marsh, stagnant water occurs.

Many persons think that if tide gates are provided, it will prevent mosquito breeding, and that no other work is necessary. But the gates keep out only tide water. Fresh water enters just the same and must be allowed to pass out. Hence drains are necessary. Tide gates only prevent the flooding of the marsh at high tide and are almost negligible so far as mosquito breeding is concerned. It is necessary to do almost as much ditching with as without a tide gate. Wherever the tide rises and falls in the ditches, mosquitoes will not breed.

Tide gates are of much value in salt hay farming, for they keep the marshes from becoming flooded at each perigee tide, and prevent the salt grass from becoming encrusted with salt. Hay is considerably more valuable and a much greater yield is obtained if the salt water is not allowed to flood the marshes during the growing period.

Some communities, however, have recently made a start toward improving the conditions of the marshes. Nearly seven miles of coast marsh land was drained in 1911, just east of Stamford, and the present season similar work is being done about Greenwich, Fairfield, New Haven, Branford and Saybrook. This draining has all been for the purpose of doing away with mosquitoes, and not for increasing the yield of grass, yet the latter result is gained.

MOSQUITO CONTROL.

The general methods of mosquito control are (1) draining of the marshes, (2) oiling the breeding pools and (3) screening of rain water receptacles. The first, viz. draining, is the method

to be chiefly considered in connection with the present control of the mosquito nuisance; the second may be employed temporarily until the draining can be carried out, and the third should receive attention each year.

METHODS OF DRAINING.

Where there is a natural stream flowing through the center of the marsh, the area may be satisfactorily drained by cutting simple lateral ditches running nearly at right angles to the axis of the stream, with the outlets bearing slightly toward its mouth. These lateral ditches should be narrow—not more than ten inches wide—and from 24 to 30 inches deep, according to the character and size of the area to be drained. If there is no stream for an outlet, then a broad central ditch must be cut. This should be fully as deep as the laterals and wide enough to carry off the water supplied by them. The lateral ditches should be parallel with each other and from one hundred to one hundred and fifty feet apart, according to the condition of the marsh. It is not necessary to connect each pool with the tide water in ditching, as the seepage is so great through the porous peat of the salt marshes that pools are often drained and become dry at a distance of sixty or more feet from the ditch.

In draining some Connecticut marshes clay or gravel is encountered in the bottom of the ditch. It is not necessary to cut into this material unless it is near the central ditch where it will trap the water.

Ditches cut years ago for salt hay farming were shallow and open. Such ditches are not recommended and are not being cut at the present time in mosquito extermination drainage work. Shallow and open ditches are easily clogged by floating *debris* and vegetation grows in them readily, choking them and rendering them ineffective. Deep narrow ditches, on the other hand, remain in working condition for a number of years and are seldom clogged by vegetation. All marsh areas should be given attention, however, because in high tides, sods from the ditches, hay, driftwood or other *debris* may float into the ditches and clog them. By a frequent and systematic patrol of the area such conditions may be detected and remedied at once.

Such ditches as are mentioned above can best be cut with hand tools made for the purpose, shown on Plate II, but on the

a. Mosquito breeding pools on salt marsh near Morris Cove.

b. The same view as above showing ditch.

PLATE II.

a. Draining the salt marsh. The spade raised ready to be plunged into the peat.

b. Rolling away the turf.

a. The Skinner ditching spade.

b. This pool half way between ditches has been drained.

PLATE IV.

a. Oiling breeding pools Sandy Point marsh. Stakes and flags mark breeding pools.

b. Oiling pools in West River marsh.

larger marsh areas of New Jersey power machines may be employed to advantage.

There are always small depressions which should be filled and can be filled easier and cheaper than they could be drained. This is particularly true in the hard land. There are also certain depressions where on account of the expense draining is impracticable. These may be treated by dredging out the center and filling the banks with the material excavated, thus concentrating the water in a permanent pool which should be stocked with fish.

COST OF DRAINING MARSH LAND.

The cost of draining salt marsh land is not prohibitive. In fact it is actually less than most persons expect. From contracts which have been made recently for such work, and from conversing with the contractors, we may state that the salt marshes of Connecticut may be drained, so that they will not breed mosquitoes, at a cost of between $5.00 and $10.00 per acre, or say an average of not over $8.00 per acre. As this area contains 22,264 acres the cost of draining the salt marshes of the whole State would not exceed $178,112.00, a sum insignificant considering the benefit to be derived from its judicious expenditure.

Some contracting firms are prepared to drain marsh areas at a given price per running foot of ditch, the price varying from two cents upward, according to the amount and character of the work to be done.

On some of the large marsh areas of New Jersey, ditches have been cut by power machines at a price as low as one cent per running foot of ditch, and contracts have been made for draining certain definite areas at less than $2.00 per acre.

RESULTS OF DRAINING SALT MARSH.

Wherever salt marsh is properly drained the land rises perceptibly, becomes much harder than before and there is no stagnant water upon it; mosquitoes cannot breed thereon, and consequently all land in the vicinity of the marsh becomes more desirable for residence purposes. If depressions occur and fill with water at flood tide, it will soon seep away before mosquitoes can develop in it. As the land becomes firmer it is easier to get over it, especially with a team, for cutting and removing the salt

hay. The character of the vegetation soon changes and the spike grass *Distichlis maritima,* which is characteristic of breeding areas and which always produces a small yield of poor quality hay, gives way to black grass *Juncus gerardi,* which makes the best salt hay and which all over the marsh gives a much greater yield after draining. During the summer a practiced eye can tell at a glance, by the color of the marsh, which portions of it are well drained, showing the bright green of the black grass, contrasting with duller green or gray of the spike grass and the other marsh vegetation of the ill-drained areas.

The yield is often increased three or four fold by simple draining, and land has been known to produce twenty times as much after the operation.*

Such an increase in yield might, even with the crop of a single season, more than pay the cost of draining. But this increase keeps up as long as the drains work and the total increase in yield and quality of the crop is enormous.

This yield, of course, greatly increases the income from the land, which accordingly increases in value as an investment. Surrounding property also becomes more valuable on account of the increase in the value of the marsh.

That the growing of vegetable crops on the salt marsh, where properly drained and dyked, is not impossible, nor impracticable, was demonstrated a few years ago by Mr. F. R. Sammis of Stratford, who grew some excellent celery, asparagus and onions on the big Stratford marsh. In future years, unquestionably some of our salt marsh land will be used to grow such crops.

But more particularly on account of getting rid of the mosquito plague is the benefit felt by those living near the marsh. The people are more healthy and more comfortable. Shore resorts, summer hotels and cottages, as well as permanent residences, all benefit by such improvement work. If the mosquitoes can be eliminated from the coast region of Connecticut—and they will be if we drain the marsh land—there is no more attractive place in the country where one can spend the summer. Last but not least, the railroad and transportation companies will reap a harvest in the increased summer traffic to and from the shore resorts.

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*J. B. Smith, Bulletin 207, New Jersey Agricultural Experiment Station 1907.

OILING OF BREEDING POOLS.

Where mosquito larvae or wrigglers are found in any pool, they may be killed in a few minutes by spreading a film of oil over the surface of the water. It is necessary for the larvae to come to the surface about once each two minutes to breathe, and the oil not only prevents the air from entering their respiratory system, but the oil also enters their breathing tubes, destroying the tissues, and they soon die.

The oil must be applied about once each ten days to keep the pool in a safe non-breeding condition. For this purpose ordinary kerosene, which can be purchased from any grocer, will answer. Some prefer a heavier oil, called light fuel oil. One grade sold by the Standard Oil Co. as "34° Distillate" has been recommended for this work.

Oiling at its best is but a temporary expedient, and should be practiced on the salt marsh only until the marsh can be drained. In mid summer the tall vegetation often obscures many small breeding places, and likewise makes it difficult to distribute the oil on the surface of the water, where needed,—most of it striking the vegetation.

A convenient method of applying oil is by means of small compressed air sprayers with cylinders of galvanized sheet iron. Each cylinder contains a pressure pump and will hold about two and one half gallons of liquid. It may be carried in the hand or held by a strap thrown over the shoulder. Such an outfit, including short piece of hose with nozzle, may be purchased for $4.50. A two-foot extension rod is almost a necessity and costs thirty-five cents extra.

Where large areas are to be treated, barrels of oil should be distributed at various convenient points, in or around the marsh.

The amount of oil to be applied is one fluid ounce to each fifteen square feet of water surface. A less quantity will often fail to kill the wrigglers.

SCREENING OF RAIN WATER RECEPTACLES.

Many shore cottages are not connected with the water supply of the villages or cities, but rain water is collected from their roofs and conducted into barrels or cisterns, from which it may be drawn as needed. Where these barrels or cisterns

are above ground and uncovered, *Culex pipiens* will certainly breed in them. Such receptacles should always be screened, and if it is necessary to take water from the top of the barrel, mosquito netting tacked upon a hoop, somewhat larger than the top of the barrel, can be placed over it and removed at pleasure, and mosquitoes cannot reach the water to lay their eggs.

Tin cans, kettles, broken bottles, clogged gutters and other receptacles on the dump or scattered promiscuously, are prolific breeding places wherever they contain water for a week or more and should never be tolerated.

COMMUNITY EFFORT IN MOSQUITO CONTROL.

In any work directed toward the control of mosquitoes in the salt marsh region, little will be accomplished except through coöperation. If one marsh is drained, some relief will be felt by those residing near it and especially on the inland side of it. But in order to really do away with the mosquito nuisance, all salt marsh areas for a distance of several miles should be drained. In the absence of State legislation, this can be done only through community effort, as the separate property owners will not as a rule coöperate effectively to such an extent, and many of them will not expend a dollar for such improvement work on their own land. If money is raised by subscription and enough procured, then large areas, beginning with the worst ones, can be treated and relief obtained.

Lower prices for draining work will be obtained through coöperation than could possibly result if each owner arranged by himself for having it done.

LEGISLATION NEEDED.

Though much can be accomplished through the coöperation of adjacent communities in treating salt marshes for the purpose of controlling mosquitoes, in order to gain the greatest benefits to all concerned, some state-wide movement should be inaugurated. Authority to drain marshes whether the owner desires it or not, should be conferred upon some officer or commission, especially where it benefits the whole community, the town and the state, without injuring the property or working any hardship to its owner.

Just what arrangement would be best has not been determined, but if the State could bear a part of the expense—perhaps one-half, and give the work proper supervision and insist on its maintenance—and the remaining portion be met by the town and the owner, each paying a certain definite percentage, in just proportion to the benefits received, it would seem to be the most desirable solution of the problem.

The salt marshes are owned by a large number of free holders, some of whom are non-residents. Most of the owners, if they can be found, are willing to have their lands drained, but occasionally an owner objects, and he is thus able to block a work which, if carried through, would be a great benefit to the whole community or town, including himself.

Legislation is therefore essential to provide for the systematic and wholesale draining of the salt marsh areas of the State.

SUMMARY.

The mosquito plague of Southern Connecticut is composed chiefly of two species of salt marsh mosquitoes—the brown salt marsh mosquito, *Culex cantator* Coq., and the banded salt marsh mosquito, *Culex sollicitans* Walk., which breed in the brackish stagnant pools of the salt marshes and fly inland several miles in search of their food, viz. the blood of the higher animals.

The rain barrel mosquito *Culex pipiens* Linn. breeds in rain water barrels, tin cans and other receptacles along the shore, and certain other species of *Culex,* as well as the malarial mosquito, *Anopheles,* may breed in the fresh water pools next to the highland, yet these are all local, fly only short distances and form only a small part of the mosquito plague of the coast region.

The salt marsh region of Connecticut contains 34.79 square miles, or 22,264 acres, more than half of which has in past years been drained for salt hay farming. During recent years the marshes have received little attention, the ditches have become filled and probably breed more mosquitoes than they did thirty or forty years ago.

The conditions are such as to check the proper and natural development of the Connecticut coast region as a site for summer homes; the land produces little, and is unprofitable, yet taxes are collected upon it.

Tide gates in proper working condition will keep tide water from flowing over the marsh but do not prevent the fresh water entering the marsh from the highland. This must escape to the ocean and draining is the only treatment to be advised. Narrow deep ditches are much more permanent than broad shallow ones. The lateral ditches should be not more than ten inches wide and from 24 to 30 inches deep, and placed from 100 to 150 feet apart, running parallel with each other, and nearly at right angles to the main stream or the broad central ditch.

The cost of draining the Connecticut marshes will vary, but may be done by contract at from $5.00 to $10.00 per acre, and should not average more than $8.00. The entire salt marsh area of Connecticut can be drained for less than $200,000.00.

The increase in yield of salt marsh hay will soon pay the cost of draining and may do so in a single season.

Mosquito wrigglers may be killed by oiling the breeding pools, but this should be considered as only a temporary measure and should not be advocated in place of draining.

The methods of draining and oiling are shown on the plates, and described in detail on the pages of this bulletin. Coöperation of individuals and communities are necessary for successful results in this work, and many towns and communities have taken it up. Legislation, however, is needed, and a State-wide movement with some State supervision would seem to be the best solution of the problem.